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### Saving Energy in High Temperature Grain Drying

Cooperative Extension South Dakota State University

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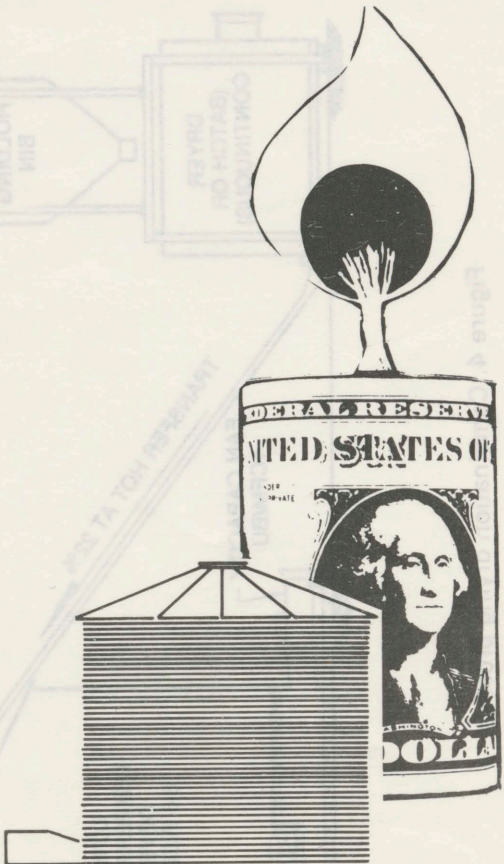
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# SAVING ENERGY IN HIGH TEMPERATURE GRAIN DRYING



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## SAVING ENERGY IN HIGH TEMPERATURE GRAIN DRYING

Grain is normally harvested at a higher moisture content than is needed for storage or marketing. This reduces field losses due to weather and harvesting, which become greater as the crop dries in the field. High temperature drying is the most common method of lowering moisture content of grain. These drying systems are fast, relatively easy to operate, but use more energy than other grain drying systems.

Saving energy in the grain drying process is becoming more important with the continuing rise in energy prices and the possibility of petroleum fuel shortages. Energy use for drying grain can be reduced.

High temperature drying is accomplished with batch dryers, continuous flow dryers, and with larger bin type dryers (Figure 1). All dryers operate by forcing heated air through grain, removing excess moisture. Changes in either air temperature or airflow rate will change the drying rate. As the grain is dried, the grain closest to the heater will dry first and will always have lower moisture contents and higher temperatures than the grain farther away. The grain is cooled prior to leaving the dryer by forcing unheated air through it.

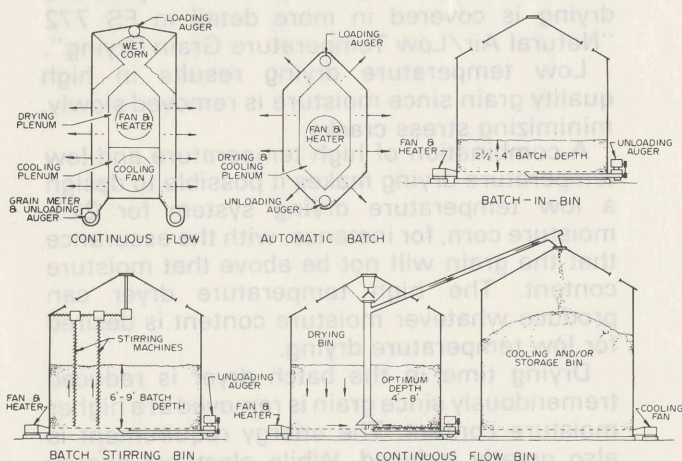


Figure 1. Schematic diagrams for five types of high-speed dryers. (Source: M-161, Saving Energy in Corn Drying, University of Minnesota.)

Grain depth is limited to between 2½ and 4 feet in a bin dryer to keep overdrying of grain on the bottom to a minimum. Drying grain to moisture contents below 15½% uses costly energy and removes water that can be sold with the grain. By using a stirring device you can mix the grain, reduce overdrying, and increase grain depth to between 6 and 8 feet.

Several things can be done to reduce the energy used in high temperature dryers.

- Screen out trash
- Operate the dryer at recommended settings
- Cool in the storage bin
- Use dryeration
- Use a combination of high temperature and low temperature drying

### Screen Out Trash

Screen grain prior to drying to remove fines and foreign material. Grain containing fine material resists air movement more than clean grain, resulting in lower airflow rates. Broken kernels and fines will spoil faster than whole kernels in storage. If screening is done prior to storage but after drying, energy is needed to dry this material. High moisture screenings can be fed with silage so that food value is not lost. However, high moisture screenings will spoil if not dried, fed, or stored with silage.

### Make Recommended Adjustments

Dryers adjusted according to manufacturers recommendations use energy efficiently. Reducing air temperature in an attempt to reduce energy does not lower total energy use (see Figure 2). A dryer operated at 75 cubic feet per minute per bushel (cfm/bu) and 200°F will use about 2800 BTU per pound of water evaporated while lowering temperature to 150° will increase energy usage to about 3900 BTU per pound. Reducing airflow rate or increasing temperature will reduce total energy consumption but will overdry the grain closest to the heaters and cause a larger difference in moisture content from one side of the grain layer to the other.

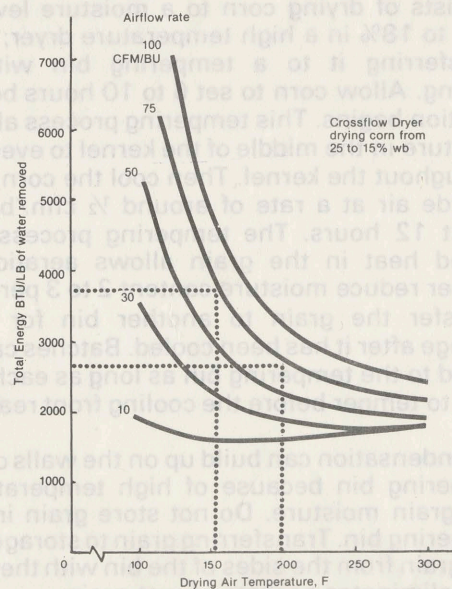


Figure 2. Energy requirements of a conventional crossflow dryer as a function of drying air temperature and airflow rate. (Source: University of Nebraska, 1975.)



Use the highest temperature that will not damage corn quality. The maximum kernel temperature for grain to be used for seed is 110°F. A kernel temperature of 125°F will kill the seed germ. A maximum kernel temperature for grain that is to be marketed is 140°F and 190°F is maximum for feed grain. Evaporation of moisture tends to cool grain, but the temperature will rise as grain dries out. Collect a grain sample near the end of the drying cycle to check temperature.

### Cooling In Storage

Cooling in storage rather than in the dryer will increase drying capacity and save energy. Cooling grain removes an additional ½ to 1% moisture. An airflow rate of at least one quarter (¼) cfm/bu is recommended for cooling. Turn the cooling fan on as soon as grain is put in storage to reduce condensation that will occur on the sidewalls and roof of the bin.

Move cooling air from the bottom of the bin up through the grain. This movement pattern allows warm grain to be added to the top of previously cooled grain.

Utilizing in-storage cooling decreases the amount of time a batch of grain is in the dryer, thus increasing the number of batches that can be dried in a day.

### Use Dryeration

Dyeration, Figure 3, will save more energy than in-storage cooling. The dyeration process consists of drying corn to a moisture level of 16½ to 18% in a high temperature dryer; then transferring it to a tempering bin without cooling. Allow corn to set 6 to 10 hours before aeration begins. This tempering process allows moisture in the middle of the kernel to even out throughout the kernel. Then cool the corn with outside air at a rate of around ½ cfm/bu for about 12 hours. The tempering process and stored heat in the grain allows aeration to further reduce moisture content 2 to 3 percent. Transfer the grain to another bin for final storage after it has been cooled. Batches can be added to the tempering bin as long as each has time to temper before the cooling front reaches it.

Condensation can build up on the walls of the tempering bin because of high temperatures and grain moisture. Do not store grain in the tempering bin. Transferring grain to storage will mix grain from the sides of the bin with the rest. This eliminates pockets of wet grain.

Drying removes moisture from the kernel's outer layers first. Moisture from the kernel center must move to the outer layers before it can be removed, requiring both time and extra energy. Removing the last few percentage points of moisture in the tempering bin reduces the amount of energy used in the high temperature dryer. The grain is also in the dryer for a shorter period, increasing the amount of grain that can be dried in a day.

Dyeration results in better quality grain than drying strictly with a high temperature dryer. The high grain temperature reached in the dryer along with rapid cooling results in stress cracks in the seed coat. These make the kernels more susceptible to damage during subsequent handling operations. The tempering process in dyeration helps minimize this problem.

### Use Combination Drying

Combination drying, Figure 4, is a system of using a high temperature dryer to remove the higher moisture levels; then transferring partly dried grain to a low temperature, in-storage drying bin to complete the process.

Low temperature drying uses the natural drying qualities of outside air to dry grain. A small amount of heat, (2 to 10 degrees) is added to aid drying. Natural air drying (no heat added) can also be used. Low temperature drying requires about 1,200 BTU per pound of water removed, compared with 2,000 to 3,000 BTU per pound for high speed drying. However, low temperature drying requires 6 to 8 weeks. The long drying time limits the initial moisture content of the grain, since high moisture grain may spoil before it gets dry. Low temperature drying is covered in more detail in FS 772 "Natural Air/Low Temperature Grain Drying".

Low temperature drying results in high quality grain since moisture is removed slowly, minimizing stress cracks.

A combination of high temperature and low temperature drying makes it possible to design a low temperature drying system for 22% moisture corn, for instance, with the assurance that the grain will not be above that moisture content. The high temperature dryer can produce whatever moisture content is desired for low temperature drying.

Drying time in the batch dryer is reduced tremendously since grain is removed at a higher moisture content. The energy requirement is also greatly reduced. While electrical energy will be increased due to the fan requirements of the low temperature dryer, the petroleum based energy needs drop drastically hence, total energy is reduced.



### Additional Equipment

Additional equipment may be required in order to utilize some energy saving options. For example, aeration systems are needed in storage bins, but these should already be present for proper management of stored grain or in-storage cooling may require larger aeration fans.

Dryeration will require at least one and possibly two tempering bins with aeration. Extra grain handling equipment may also be needed.

Combination drying requires storage bins with drying floors plus fans that can deliver air at the rate of (1) cfm/bu of corn in storage.

One or a combination of several of the above methods can be used to reduce the energy required to dry grain. Proper adjustment and drying to the proper moisture content can be done by any operator. Some producers will be able to use in-storage cooling for some of their grain and combination drying for the rest. Others may only be able to use one of these methods in addition to drying with a high speed dryer.

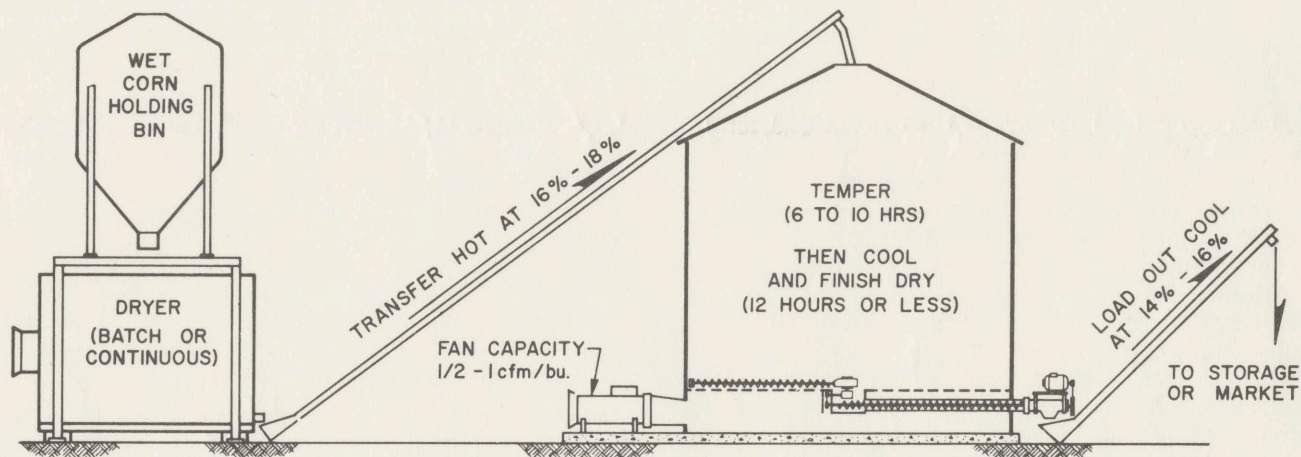


Figure 3. Dryeration process. (Source: A2379, Shelled Corn Drying In Wisconsin, University of Wisconsin.)

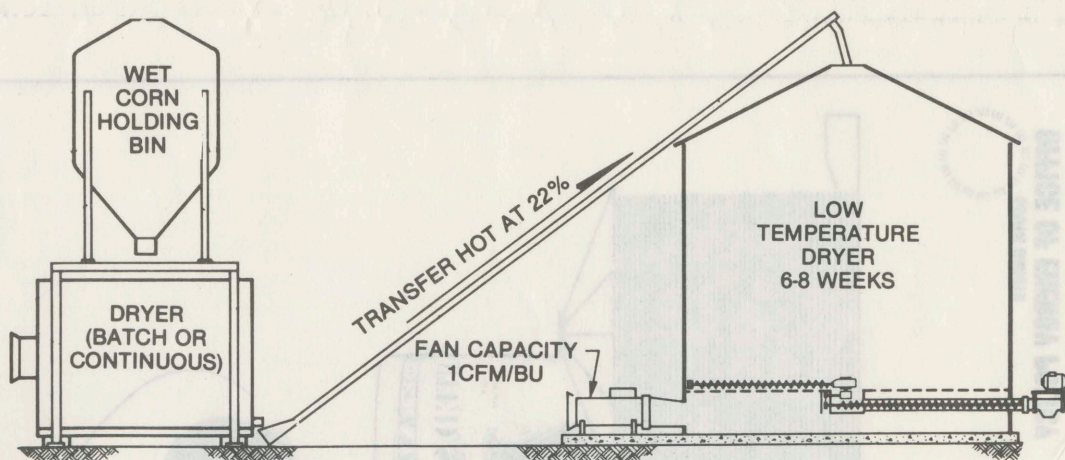


Figure 4. Combination drying process.